



Research and Development Report

FURTHER MEASUREMENTS OF THE SOUND INSULATIONS OF METAL-FRAMED PARTITIONS

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Summary

The sound insulations were measured of a number of single and double leaf metal-framed partitions. The purpose of the work was to develop alternative designs for partitions to that of the Camden. The Camden contains fibreboard as one of its constituent elements. The new partitions used plasterboard as the sole board material. Therefore, the new partitions were heavier than the comparable metal-framed partitions.

The levels of sound insulation achieved from the new partitions were generally slightly higher than those of comparable metal-framed Camdens. However, the greater masses of the new partitions may rule out their use in certain circumstances because of the loadbearing requirements of the surrounding building.

The installation of glass wool insulation batts in the cavities of the new partitions resulted in large increases in the measured sound insulations. The glass wool damps the motion of the boards and absorbs sound that has been transmitted into the cavities.

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FURTHER MEASUREMENTS OF THE SOUND INSULATIONS OF METAL-FRAMED PARTITIONS

G.D. Plumb, M.A. (Cantab.)

1. INTRODUCTION

The 'Camden' is a lightweight partition used in BBC studio construction. It has a high level of sound insulation for its weight. It consists of a framework of studding, clad with a layer of 12.5 mm thick fibreboard each side, followed by a layer of 12.5 mm plasterboard each side. The internal cavity width is typically 70 - 75 mm. In most studios made from Camdens, the partitions are timber-framed¹. Recently, there has been a move towards the use of partitions having metal frames².

Partitions containing plasterboard and fibreboard, such as the Camden, have high sound insulations for their weights because of the properties of the fibreboard. The fibreboard damps the motion of the plasterboard and acts as a vibration break between the plasterboard and the studs. It also acoustically breaks the cavity and help to reduce wave coincidence effects³ that would have occurred if the same board type had been used throughout the partition.

Existing BBC designs for metal-framed partitions^{2, 4, 5} are made from Lafarge products. British Gypsum manufacture a range of products suitable for the construction of similar metal-framed partitions.

British Gypsum were unable to provide maximum loading figures or fire ratings for partitions containing fibreboard. Therefore, new designs were investigated which contained different thicknesses of plasterboard. The new designs would be less likely to suffer from the large coincidence dips in sound insulation at 2.5 - 3.15 kHz, that occur in partitions constructed from 12.5 mm plasterboard throughout. The coincidence frequency of a board is affected both by the material from which the board is made and by the thickness of the board. The coincidence frequencies of plasterboard and fibreboard are sufficiently different that the depth of the coincidence dip for the Camden is very small. The combination of two different thicknesses of plasterboard (namely 15 mm and 9.5 mm), instead of a combination of 12.5 mm plasterboard and 12.5 mm fibreboard, should also reduce the depth of the coincidence dip, whilst maintaining the same overall partition thickness.

The resultant partitions would be heavier than the metal-framed Camden, the cavity would have less acoustic treatment, there would be no vibration break between the plasterboard and the studs, and the

plasterboard would be less heavily damped. However, the new partitions would typically have greater fire resistances and permissible heights than those of the Camden.

This Report describes sound insulation measurements made in the Research and Development Department Transmission Suite on a number of different designs of partition. The intention was to verify that the new partitions would have acceptable levels of sound insulation in comparison to those of the Camden. The work was undertaken as a collaborative project with British Gypsum, who supplied the materials and labour for the construction of the partitions, free of charge.

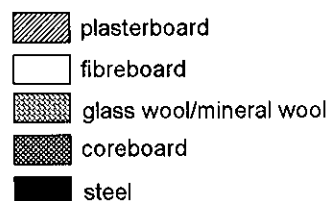
Some practical construction details are mentioned at this stage, which were common to all the partitions tested. Unless otherwise stated, all measurements were made in the Research and Development Department Transmission Suite. The two leaves of double leaf partitions were independently constructed in the openings in the source and receive room walls. Care was taken to ensure that the two leaves were structurally independent, to simulate the way they would be mounted in practice.

For reference, Fig. 1 shows the symbols used in the keys to all subsequent measurement graphs.

2. PRELIMINARY MEASUREMENTS

Fig. 2 (*overleaf*) shows the sound insulations of three different single leaf partitions made from 50 mm

materials used :



board thicknesses :



Fig. 1 - Symbols used in the keys for the graphs.

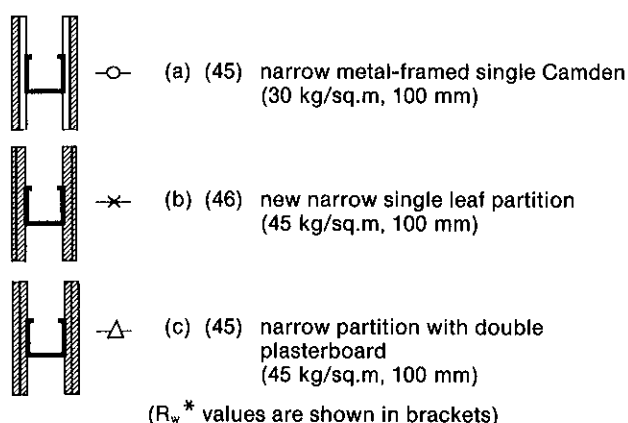
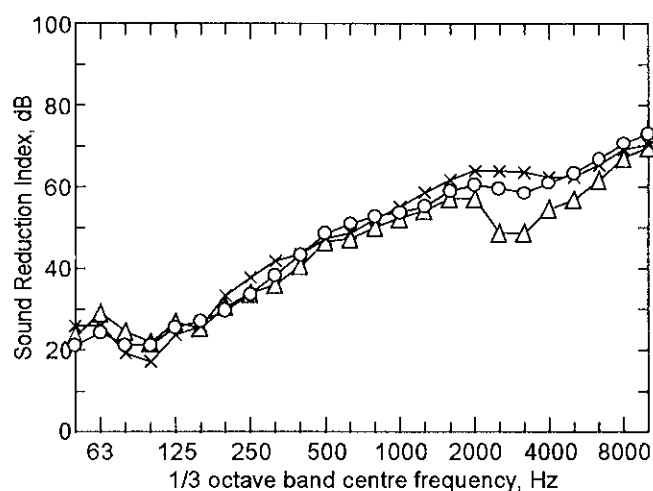


Fig. 2 - The sound insulations of narrow, single leaf, metal-framed partitions.

metal 'C' studs. The graph shows the effects of different cladding boards on the sound insulations. For the partition of Fig. 2(a), the studs were clad with a single layer of 12.5 mm thick fibreboard each side, followed by a 12.5 mm layer of plasterboard each side (this is a narrow version of the single Camden). For the partition of Fig. 2(b), the studs were clad with a layer of 15 mm plasterboard each side, followed by a layer of 9.5 mm plasterboard each side. For reference, Fig. 2(c) shows the sound insulation of a partition clad with a double layer of 12.5 mm plasterboard each side. (Note that the combined thicknesses of the boards on each side of the studs are effectively the same for the three partitions. For reference, overall partition weights and thicknesses are included in the keys for the figures.)

Except in the range 2 kHz to 8 kHz, the three sound insulation curves are quite similar. Differences between them may be linked with the considerable differences between the times at which the measurements were made, differences in construction techniques and differences in the materials used. The

differences between 2 kHz and 8 kHz, are due to wave coincidence effects. The partition with a double layer of 12.5 mm plasterboard (Fig. 2(c)) each side has a pronounced coincidence dip at 2.5 - 3.15 kHz. For the partition with one layer of 12.5 mm fibreboard and one layer of 12.5 mm plasterboard each side (Fig. 2(a)), the coincidence dip is virtually non-existent because the different boards have very different coincidence frequencies. The partition having one layer of 15 mm plasterboard and one layer of 9.5 mm plasterboard each side (Fig. 2(b)) has the highest sound insulations of the three partitions between 2 kHz and 4 kHz. This shows that the two board thicknesses are sufficiently different to overcome the effects of wave coincidence. The Appendix shows a reproducibility comparison that was carried out between the BBC Research and Development Department and British Gypsum transmission suites for the measured sound insulations of the partition shown in Fig. 2(b).

3. SINGLE LEAF MEASUREMENTS

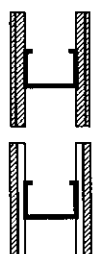
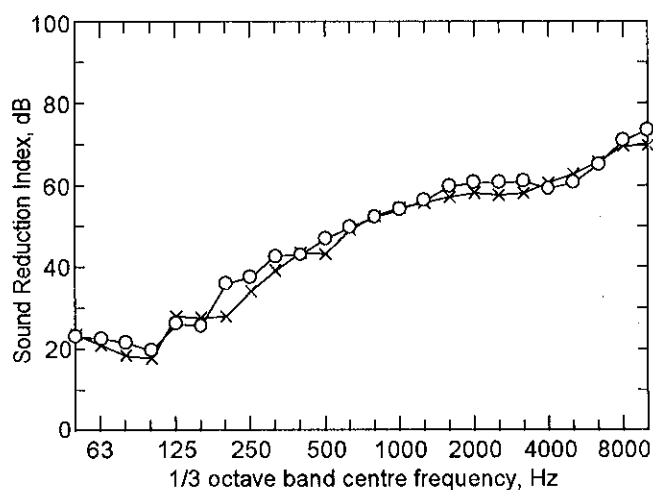
3.1 Conventional thickness partitions

Fig. 3(a) shows the measured sound insulation of a partition consisting of 70 mm studs clad each side; first, with a layer of 15 mm plasterboard, and then with a layer of 9.5 mm plasterboard. Also shown for comparison (Fig. 3(b)) is the sound insulation of a metal-framed single Camden. The two sound insulation curves are quite similar, although the new partition has a slightly higher overall performance.

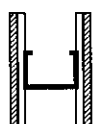
The double plasterboard layer has approximately 50% more mass than the plasterboard-fibreboard combination in the single Camden. This explains why the sound insulations of the new partition are typically slightly higher than those of the metal-framed Camden. Overall, this additional mass of the new partition more than compensates for the lower damping of the plasterboard, the lower level of acoustic treatment in the cavity and the lack of a vibration break between the plasterboard and the studs. The coincidence dip for the combined 15 mm plasterboard and 9.5 mm plasterboard is higher in frequency than that for the combined 12.5 mm fibreboard and 12.5 mm plasterboard.

Fig. 4 shows the sound insulations of single leaf partitions similar to those in Fig. 3, except that acoustic treatment had been installed in the cavities of the partitions. The cavity of the new partition (Fig. 4(a)) was filled with 75 mm thick glass wool batts. The cavity of the metal-framed Camden (Fig. 4(b)) was filled with 75 mm thick mineral wool batts.

* As defined in BS 5821: Part 1: 1984.



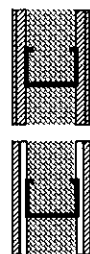
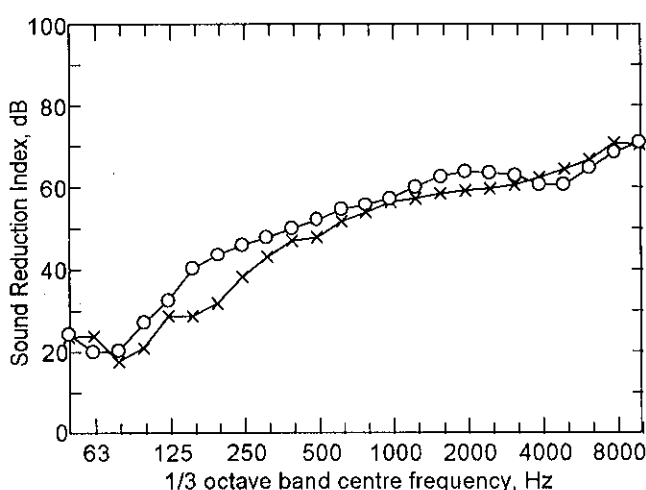
—○— (a) (47) new single leaf partition
(45 kg/sq.m, 120 mm)



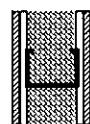
—×— (b) (45) metal-framed single Camden
(30 kg/sq.m, 120 mm)

(R_w values are shown in brackets)

Fig. 3 - The sound insulations of single leaf, metal-framed partitions.



—○— (a) (54) new single leaf partition with glass wool
(48 kg/sq.m, 120 mm)



—×— (b) (48) metal-framed single Camden with mineral wool
(33 kg/sq.m, 120 mm)

(R_w values are shown in brackets)

Fig. 4 - The sound insulations of single leaf, metal-framed partitions with treated cavities.

Overall, the new partition containing the glass wool has considerably higher sound insulations than the single Camden containing mineral wool. This is because the new partition has more mass. The effects of the installation of glass wool in the cavity of the new partition on the sound insulations were greater than those resulting from the addition of mineral wool to the single Camden. The mineral wool and glass wool damp the motions of the boards, and they acoustically treat the cavities. The fibreboard in the Camden also performs these functions. This explains why the installation of glass wool in the cavity of the relatively undamped new partition had a significant effect on the measured sound insulation; whereas the installation of mineral wool in the cavity of the partially damped Camden had a smaller effect.

3.2 Narrow partitions

This Section describes sound insulation measurements made on two narrow single leaf partitions, one without acoustic treatment in the cavity (Fig. 5, *overleaf*), and the other with acoustic treatment (Fig. 6). Fig. 5(a) shows the measured sound insulation of a narrow single leaf partition comprising 50 mm studs clad each side, first with a layer of 15 mm plasterboard and then with a layer of 9.5 mm plasterboard. Also shown (Fig. 5(b)), is the

sound insulation of a narrow metal-framed single Camden. The new partition had a lower sound insulation at 100 Hz than the narrow single Camden, probably because of different levels of internal damping for the fundamental resonances of the two partitions. The sound insulations of the new partition were typically slightly higher than those of the narrow metal-framed Camden, because the double plasterboard layer has more mass than the plasterboard-fibreboard combination in the narrow single Camden.

Fig. 6 shows the sound insulations of single leaf partitions similar to those in Fig. 5, except that acoustic treatment has been installed in the cavities of the partitions. The cavity of the new partition (Fig. 6(a)) was filled with 50 mm thick glass wool batts. The cavity of the narrow metal-framed Camden (Fig. 6(b)) was filled with 50 mm thick mineral wool batts.

Because the new partition had more mass, its sound insulations were typically considerably higher than those of the narrow single Camden containing mineral wool. As for the conventional thickness single leaf partitions, the effects of the installation of glass wool in the cavity of the new partition on the sound insulations were greater than those resulting from the installation of mineral wool in the cavity of the single Camden.

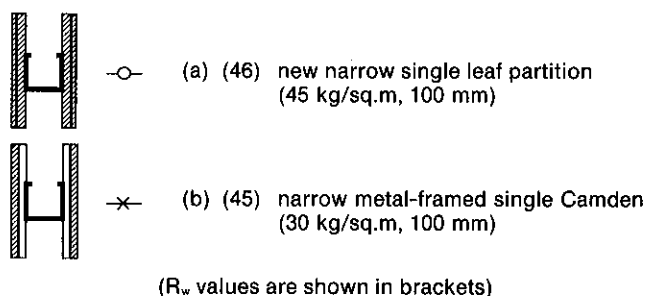
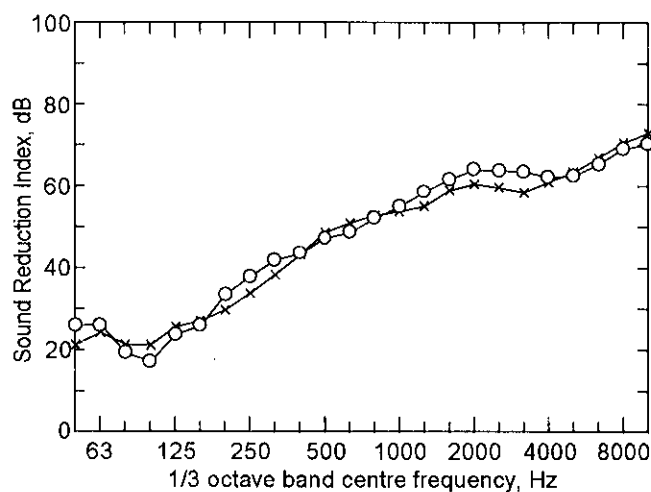


Fig. 5 - The sound insulations of narrow, single leaf, metal-framed partitions.

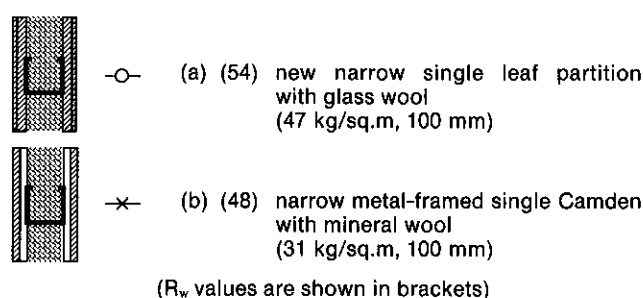
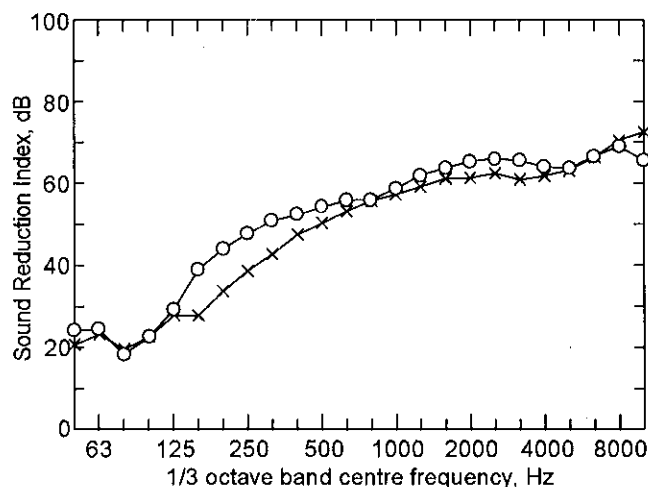


Fig. 6 - The sound insulations of narrow, single leaf, metal-framed partitions with treated cavities.

4. DOUBLE LEAF PARTITION MEASUREMENTS

4.1 Conventional thickness partitions

Fig. 7 shows the measured sound insulation of a new double leaf partition compared with that of a metal-framed double Camden. The first leaf of the new partition (Fig. 7(a)) had the same construction as the new single leaf partition described in Section 3.1. The second leaf was built 50 mm from the first leaf and comprised a Shaftwall* containing 90 mm studs. Each Shaftwall stud had two associated board retaining clips. The new system was therefore more complicated than the Shaftwall system used in the metal-framed Camden. However, the construction process did not seem to be any more time-consuming. The inner skin of the Shaftwall leaf was fitted with 19 mm coreboard and the outer faces of the studs were clad with a layer of 15 mm plasterboard which was followed by a layer of 9.5 mm plasterboard.

The new partition (Fig. 7(a)) has a similar sound insulation curve to that of the metal-framed double Camden (Fig. 7(b)), except below 100 Hz, where the new partition has significantly higher sound insulations. The differences between the two sound insulation curves can be linked with the different internal resonant frequencies of the leaves of the two partitions. The resonant frequencies are affected by the

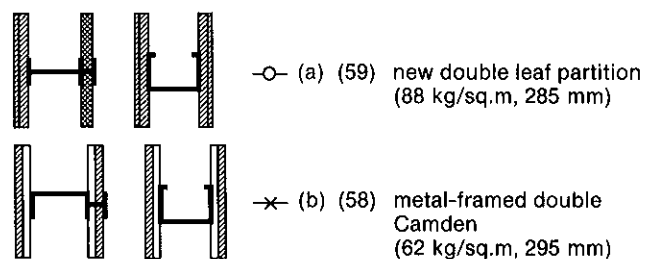
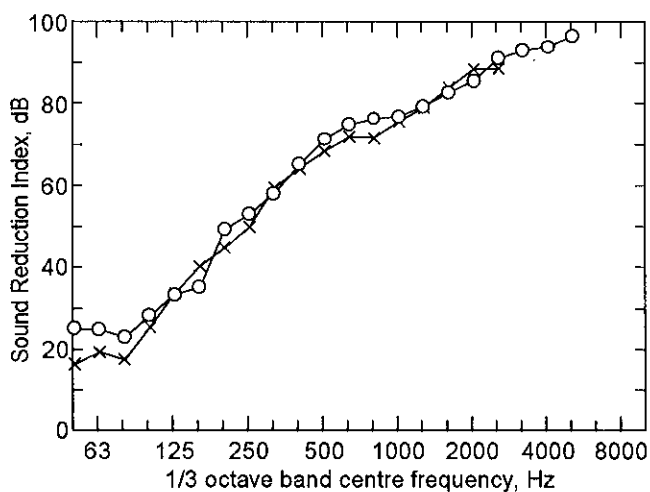
masses of the boards, the different cavity widths and the different levels of damping provided by different types of boards.

Fig. 8 shows the sound insulations of metal-framed double leaf partitions having acoustically treated cavities. The installation of glass wool in the cavities of the new partition considerably increased the measured sound insulations of the partition, particularly between 100 Hz and 500 Hz. The glass wool absorbs sound that has leaked into the cavities and damps the motion of the boards. The new treated partition (Fig. 8(a)) has significantly higher sound insulations than those of the double Camden treated with mineral wool (Fig. 8(b)). This is probably because the new treated partition is considerably heavier and has more internal damping and absorption than the treated double Camden.

4.2 Narrow partitions

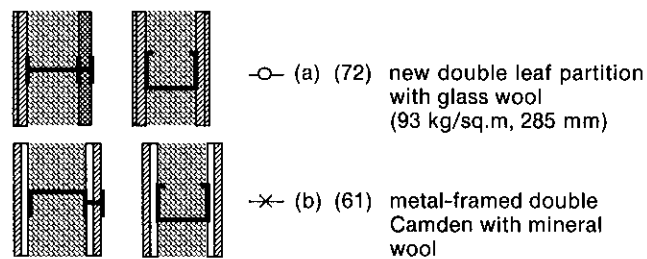
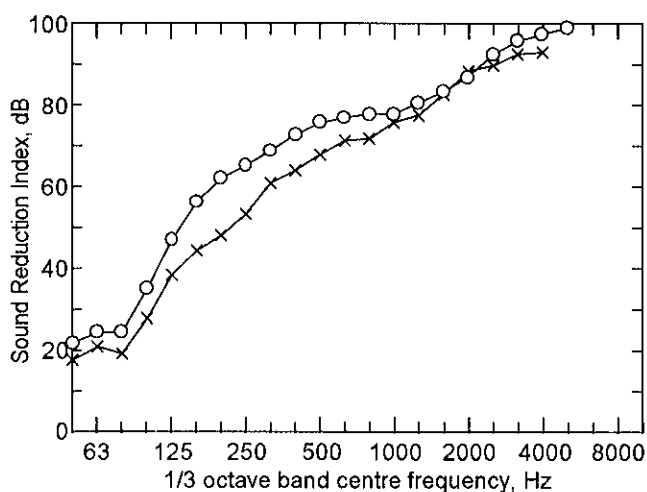
Fig. 9 shows the measured sound insulation of a new narrow double leaf partition compared with that of a narrow metal-framed double Camden. The first leaf of the new partition (Fig. 9(a)) was a narrow single leaf partition as described in Section 3.2. The second leaf was built 30 mm from the first leaf and consisted of a Shaftwall constructed from 70 mm

* A type of leaf which can be constructed from only one side.



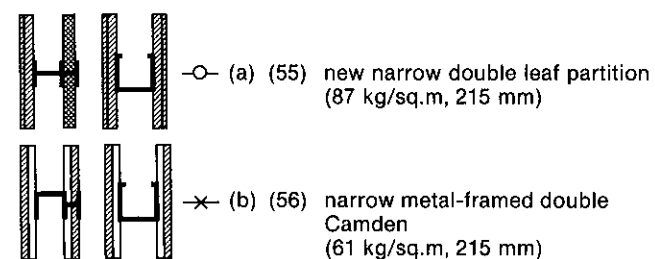
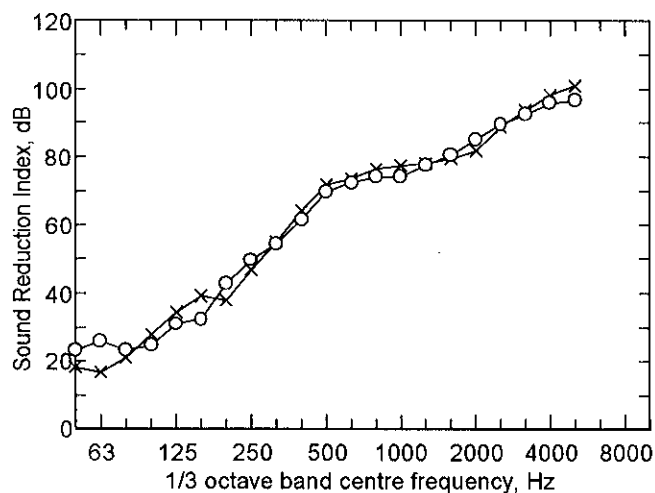
(R_w values are shown in brackets)

Fig. 7 - The sound insulations of double leaf, metal-framed partitions.



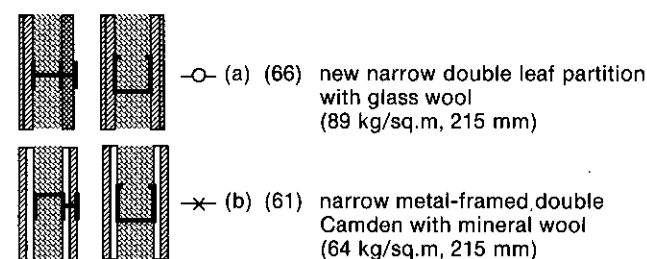
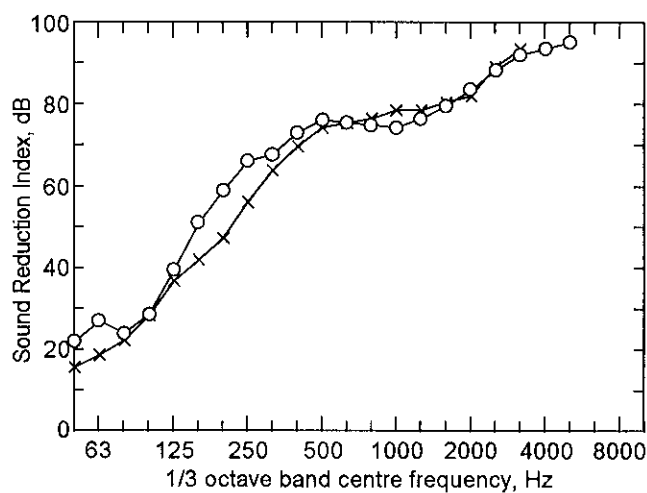
(R_w values are shown in brackets)

Fig. 8 - The sound insulations of double leaf, metal-framed partitions with treated cavities.



(R_w values are shown in brackets)

Fig. 9 - The sound insulations of narrow, double leaf, metal-framed partitions.



(R_w values are shown in brackets)

Fig. 10 - The sound insulations of narrow, double leaf, metal-framed partitions with treated cavities.

studs. The inner skin of the Shaftwall leaf was fitted with 19 mm coreboard and the outer faces of the studs were clad with a layer of 15 mm plasterboard followed by a layer of 9.5 mm plasterboard.

The new partition (Fig. 9(a)) has a similar sound insulation curve to that of the narrow metal-framed double Camden (Fig. 9(b)), except below 80 Hz where the new partition has significantly higher sound insulations, and at 160 Hz where the new partition is poorer. The differences between the two sound insulation curves can be linked with the different internal resonant frequencies of the leaves of the two partitions.

Fig. 10 (*see previous page*) shows the sound insulations of narrow metal-framed double leaf partitions having acoustically treated cavities. The installation of glass wool in the cavities of the new narrow partition considerably increased the measured sound insulations of the partition, particularly between 100 Hz and 630 Hz. The glass wool absorbs sound that has leaked into the cavities and damps the motion of the boards. The new treated partition (Fig. 10(a)) has considerably higher sound insulations than those of the narrow double Camden treated with mineral wool (Fig. 10(b)) for the reasons given in Section 4.1.

5. CONCLUSIONS

The sound insulations of the new designs for alternatives to the metal-framed single and double Camdens were typically slightly higher than those of the Camdens. The new partitions should have greater permissible heights and fire resistances than those of comparable metal-framed Camdens. However, the new partitions were heavier than equivalent Camdens. Having an alternative supplier could potentially lead to cost savings and will lessen the risks associated with reliance on one manufacturer.

For the partitions without mineral wool in their cavities, the plasterboard and coreboard layers in the new partitions were less damped and the cavities

were less treated than in the Camden. The installation of glass wool insulation in the cavities of any of the untreated partitions produced large increases in the measured sound insulations. The increases in sound insulations on installing glass wool in the cavities of the new partitions were greater than that obtained by installing mineral wool in the cavities of Camdens.

6. RECOMMENDATIONS

The use of the lightweight partitions described in this Report is recommended in situations when the maximum heights, permissible loads or fire resistances of metal-framed Camdens are inadequate. The requirements for maximum partition height, loadbearing ability, cost and achieved level of sound insulation should be considered when selecting an appropriate partition from those tested.

7. REFERENCES

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APPENDIX

A Reproducibility Comparison between Transmission Suites

Fig. A.1 shows the sound insulations of a narrow metal-framed partition, measured both in the Research and Development Department Transmission Suite and in the British Gypsum Transmission Suite. The comparison is included as an indication of the reproducibility between measurements made in the two Transmission Suites. The partition consisted of 50 mm studs clad on each side, first with a layer of 15 mm plasterboard, followed by a layer of 9.5 mm plasterboard.

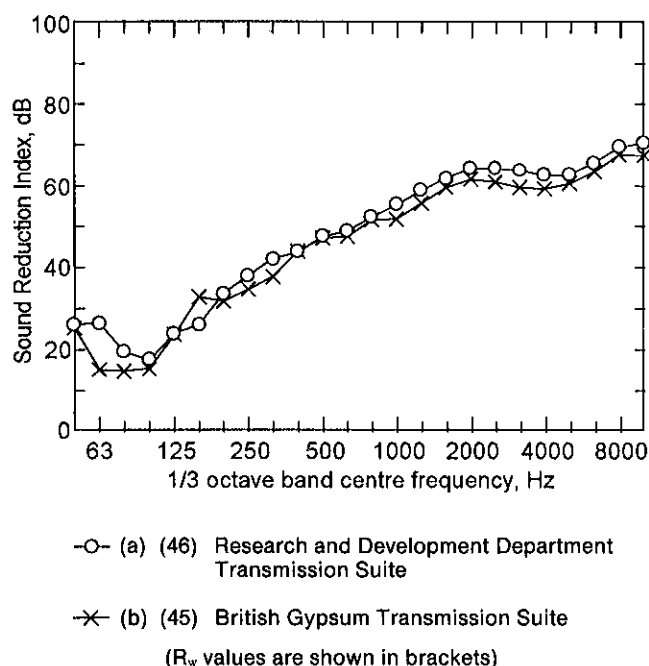


Fig. A.1 - The sound insulations of a narrow, single leaf partition measured in different Transmission Suites.

The two curves have similar shapes and overall agreement between the two curves is quite good. Differences between the two results may be linked with different construction details. The large differences between the measurements at 63 Hz and 80 Hz are probably linked with the different dimensions of the measurement rooms and of the test apertures in the two Transmission Suites.